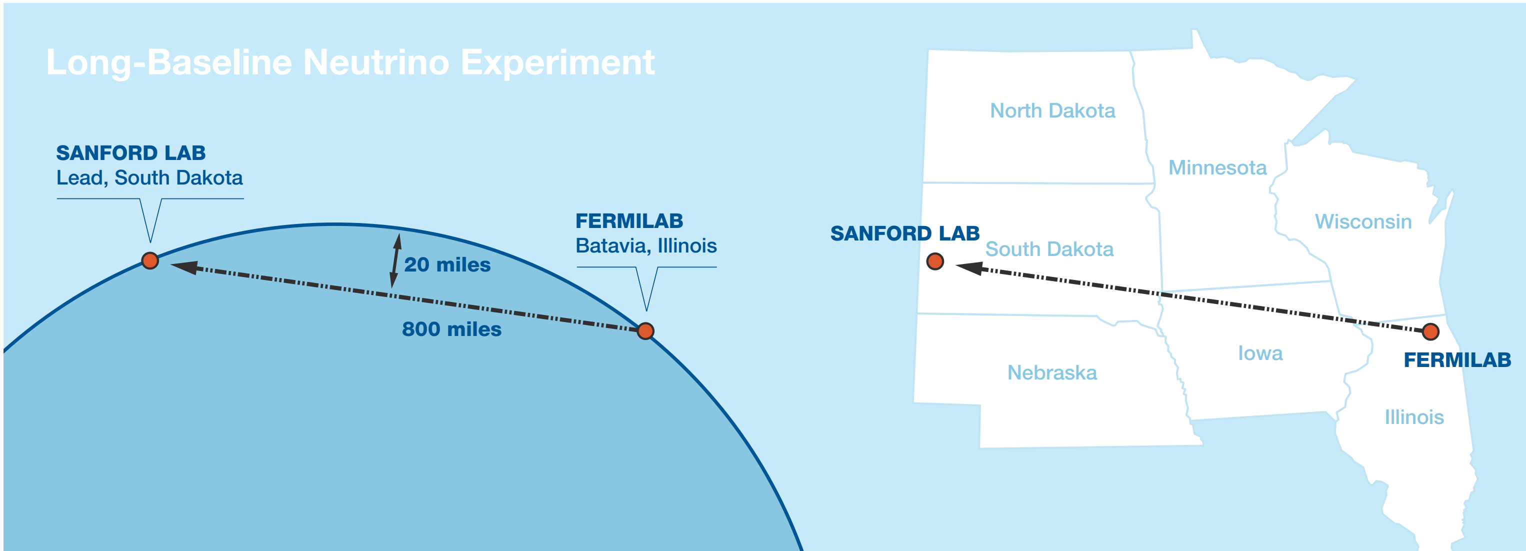
Long-Baseline Neutrino Experiment (LBNE)

A new particle physics experiment, planned to take place at Fermilab and the Sanford Lab, aims to transform our understanding of neutrinos and their role in the universe.



The proposed Long-Baseline Neutrino Experiment would send neutrinos straight through the earth from Batavia, Illinois, to Lead, South Dakota. No tunnel would be necessary for this 800-mile-long trip.

Mysterious neutrinos

Neutrinos are among the most abundant particles in the universe, a billion times more abundant than the particles that make up stars, planets and people. Each second, a trillion neutrinos from the sun and other celestial objects pass through your body. Although neutrinos are all around us, they interact so rarely with other matter that they are very difficult to observe.

The latest developments in particle accelerator and detector technology make possible promising new experiments in neutrino science. A collaboration of more than 350 scientists from five countries has proposed to build a world-leading neutrino experiment that would involve construction at both Fermi National Accelerator Laboratory (Fermilab), located in Batavia, Illinois, and the Sanford Underground Research Facility (Sanford Lab) in Lead, South Dakota.

Why are neutrinos important?

Neutrinos may provide the key to answering some of the most fundamental questions about the nature of our universe. The discovery that neutrinos have mass, contrary to what was previously thought, has revolutionized our understanding of neutrinos in the last two decades while raising new questions about matter, energy, space and time. Neutrinos may play a key role in solving the mystery of how the universe came to consist of matter rather than antimatter. They could also unveil new, exotic physical processes that have so far been beyond our reach.

Facts about neutrinos

Neutrinos are elementary particles that have no electric charge. They are among the most abundant particles in the universe.

They are very light. A neutrino weighs at least a million times less than an electron, but the precise mass is still unknown.

In nature, they are produced in great quantities in the sun and in smaller quantities in the Earth. In the laboratory, scientists can make neutrino beams with particle accelerators.

Neutrinos pass harmlessly right through matter, and only very rarely do they collide with other matter particles.

There are three types of neutrinos: electron neutrinos, muon neutrinos and tau neutrinos.

The laws of quantum mechanics allow a neutrino of one type to turn into another one as the neutrino travels long distances. And they can transform again and again. This process is called neutrino oscillation.

Understanding neutrino oscillations is the key to understanding neutrinos and their role in the universe.

The distance between Fermilab and the Sanford Lab is 800 miles. It is ideal for measuring neutrino oscillations with the proposed Long-Baseline Neutrino Experiment.

U.S. DEPARTMENT OF ENERGY · Fermilab · Sanford Underground Research Facility

Proposed LBNE neutrino beamline location on the Fermilab site

What is LBNE?

The proposed Long-Baseline Neutrino Experiment would use Fermilab's particle accelerators to create neutrinos and send them through the earth to a new, large, cutting-edge neutrino detector at the Sanford Lab. The neutrinos would travel the 800 miles from Illinois to South Dakota straight through the earth—no tunnel is needed for these particles.

The LBNE particle detector at Sanford Lab would record neutrinos and measure their oscillation properties. With the data, scientists aim to discover whether neutrinos and antineutrinos interact differently with matter. They would also be able to determine which type of neutrino is the lightest and which is the heaviest. This information would help reveal the exact role that neutrinos play in the universe.

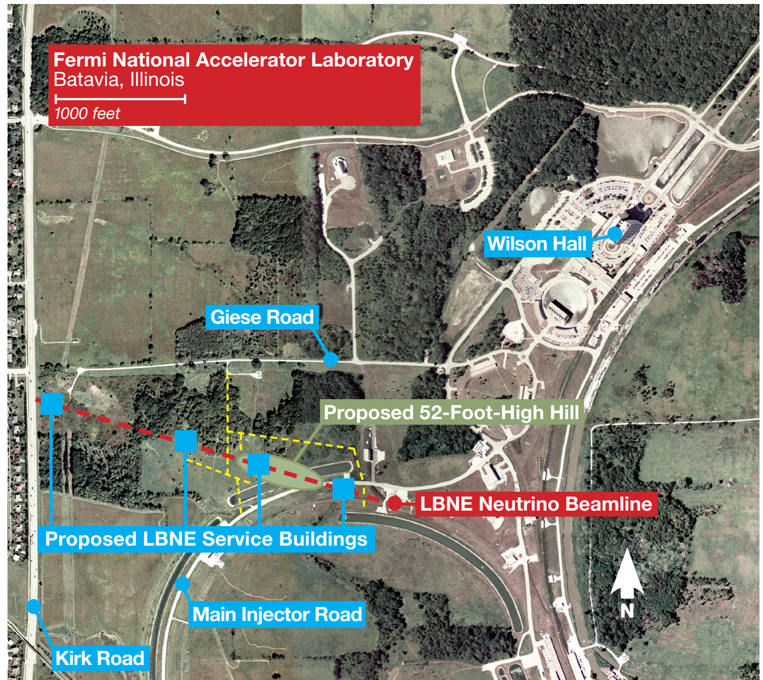
The LBNE neutrino beamline at Fermilab

Scientists can make neutrinos with particle accelerators. At Fermilab, scientists have operated neutrino-producing facilities for more than 30 years.

For the LBNE project, scientists plan to construct a new beamline to send neutrinos from Fermilab to the Sanford Lab in South Dakota. It would steer protons from Fermilab's Main Injector accelerator up a small hill (see graphic below) and then point the beam into the ground, toward the Sanford Lab. The protons would smash into a piece of graphite. The particles that emerge from these collisions would go into a 680-foot-long tunnel and generate neutrinos that travel in the same direction as the protons. With support and resources from additional partners, scientists would also build an underground hall with a particle detector that would measure the composition of the neutrino beam as it leaves the Fermilab site.

Traveling at close to the speed of light, the neutrinos would leave the Fermilab site at a depth of about 200 feet, continue straight through the earth and arrive at the Sanford Lab in South Dakota within a fraction of a second. Because neutrinos can travel through matter, no tunnel would be necessary for this 800-mile trip.

At the Sanford Lab, a large particle detector would record the arrival of the neutrinos by measuring the rare interactions of neutrinos with the detector. It would transmit the data to computers for storage and analysis. Once the experiment is operational, it would take about a decade to collect enough data to make the hoped-for discoveries that would revolutionize our understanding of the universe.



The LBNE neutrino beamline at Fermilab would be located on the western part of the Fermilab site, near Giese and Kirk roads. The locations of the four proposed service buildings are marked with blue squares and the footprint of the proposed, 52-foot-high hill is marked in green. Proposed access roads are marked in yellow. Kirk Road runs along the western boundary of the Fermilab site.

More information

LBNE website:
lbne.fnal.gov

Fermilab website:
www.fnal.gov

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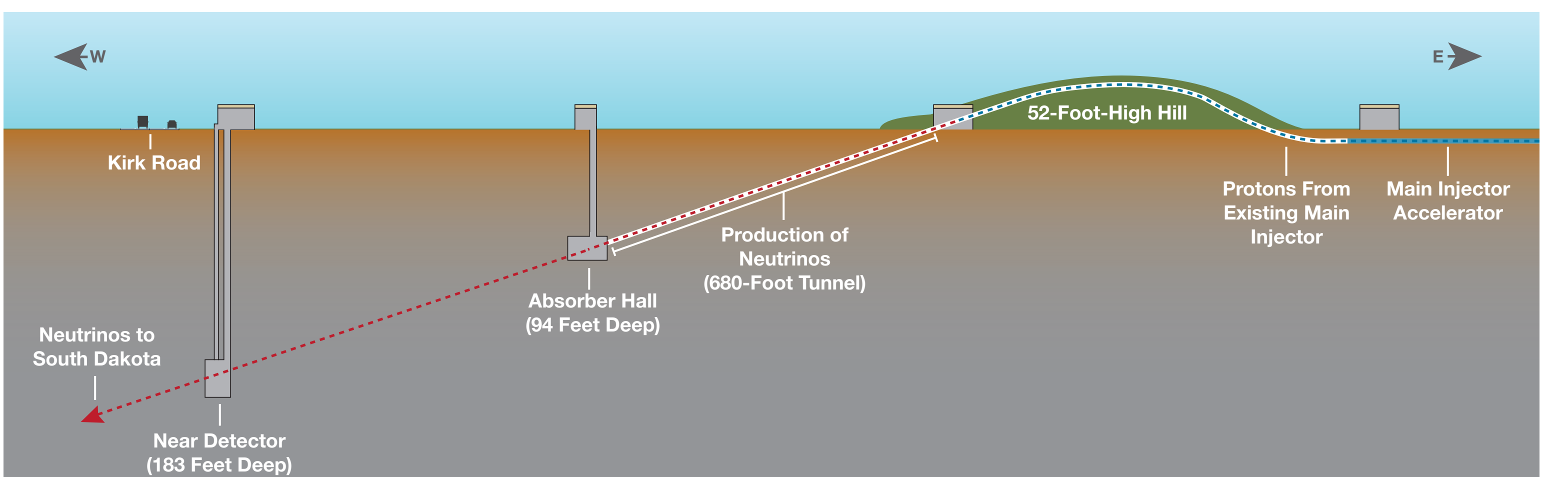


Fermilab plans to use its Main Injector accelerator to make neutrinos and send them through the earth to the LBNE particle detector in South Dakota. The project proposes the construction of four buildings, a 52-foot-high hill made of compacted soil and a 680-foot-long tunnel on the Fermilab site.

Proposed LBNE detector location on the Sanford Lab site in South Dakota

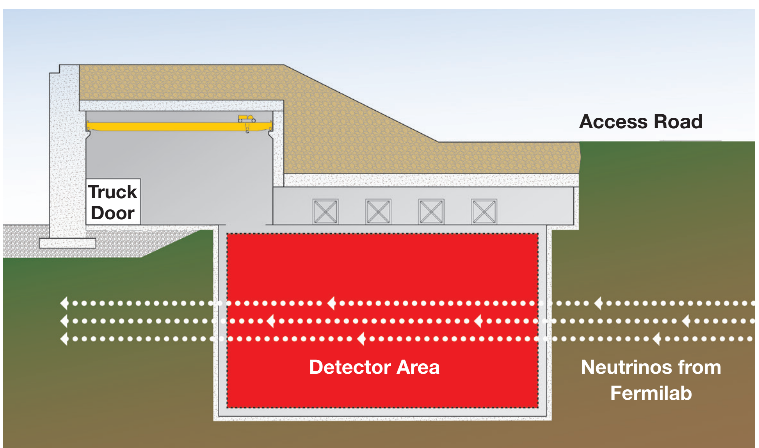
The LBNE detector at Sanford Lab

The proposed LBNE particle detector at Sanford Lab would consist of a pair of vessels that would be about 60 feet wide, 60 feet high and 100 feet long. If the LBNE detector were to be built on the surface, the two vessels would sit side by side in the large basement of a new building, to be excavated on the Sanford Lab site in surface rock east of the Oro Hondo substation. A hall on the first floor of the building would house equipment needed to construct and operate the detector. Ten feet of rock and other dense material would cover the top and the sides of the building and provide shielding from cosmic rays traveling through Earth's atmosphere.

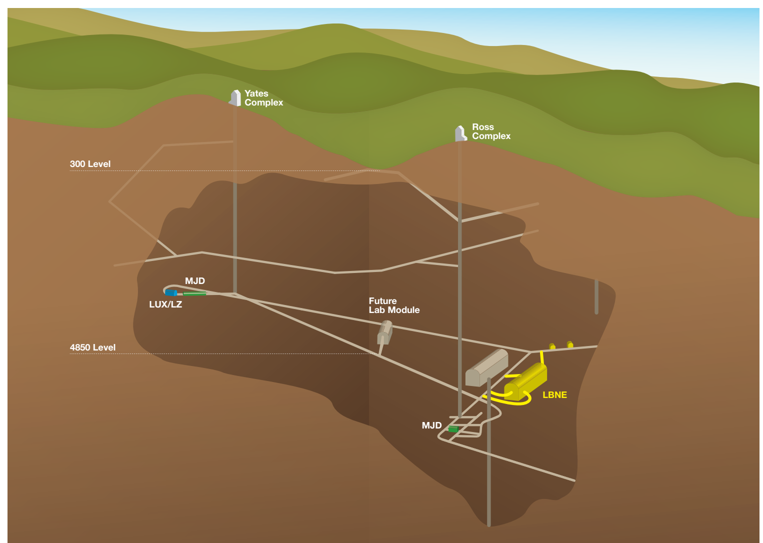
Each vessel would be filled with liquid argon, a material similar to helium, but heavier. Like helium, argon must be cooled to remain liquid. Cryogenic equipment would cool argon to minus 303 degrees Fahrenheit. Sensors would record the rare interactions between neutrinos and the nuclei of argon atoms and transmit their signals to computers for storage and analysis. LBNE scientists from around the world would have access to the data to learn more about neutrinos and their puzzling behavior.

With support and resources from additional partners, scientists would build larger particle detectors and place them deep underground, on the 4850-foot-level of the Sanford Lab. This would shield the detector more from the cosmic rays that bombard the Earth. The deeper location would greatly increase the detector's capability to identify rare interactions of neutrinos and other particles.

If the LBNE detector were to be built on the surface, it would be located in a new building to be constructed east of the Oro Hondo substation on the Sanford Lab site.



If it were to be built on the surface, the LBNE detector would be located in a building with a basement that would be about 60 feet deep and 100 feet long, to be excavated in surface rock on the Sanford Lab site. A hall on the first floor of the building would house equipment needed to construct and operate the detector. The neutrinos from Fermilab would travel straight through rock and enter the detector from the east. If additional resources become available, scientists would build the particle detector deeper underground.



With support and resources from additional partners, scientists would build the LBNE particle detector deep underground, in a new cavern to be excavated on the 4850-foot-level of the Sanford Lab. This deep location would shield the detector more from cosmic rays.

About the LBNE collaboration

More than 350 scientists and engineers from more than 60 institutions have come together to form the LBNE Science Collaboration. The collaborators come from universities and national laboratories in the United States, India, Italy, Japan and the United Kingdom. Collaborators encourage and anticipate further international participation. Funding for the collaboration is provided by the U.S. Department of Energy, the National Science Foundation as well as international funding agencies.

More information

LBNE website:
lbne.fnal.gov

Sanford Lab website:
www.sanfordlab.org

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LBNE Environmental Assessment Process

Overview

This fact sheet is intended to acquaint stakeholders—potentially affected state, tribal and local governments, interested organizations and members of the public—with the proposed Long-Baseline Neutrino Experiment (LBNE). This project would require the construction of buildings and research facilities at both Fermi National Accelerator Laboratory (Fermilab) in Batavia, Illinois, and at the Sanford Underground Research Facility (Sanford Lab) in Lead, South Dakota.

Initial project planning

The U.S. Department of Energy (DOE) has authorized the commencement of initial project planning, part of which is an investigation of the potential impacts to human health and the environment.

Start of the Environmental Assessment process

The National Environmental Policy Act (NEPA) was signed into law in 1970. It sets forth protection of the environment as a U.S. policy and requires that all federal agencies consider the potential environmental impacts of proposed projects. NEPA establishes a framework to ensure that environmental factors receive appropriate consideration along with economic and technical factors in federal agency decision-making. Accordingly, an Environmental Assessment document is being prepared for the LBNE. Information about the LBNE project and the Environmental Assessment process is being distributed through letters, fact sheets and websites. DOE will hold public informational meetings at Fermilab in Illinois on May 23, 2013, and on June 25-26, 2013, in South Dakota. For more information visit the Web: lbne.fnal.gov/env-assessment.shtml

Preparation of the Draft Environmental Assessment

With the help of a number of technical experts, including independent consultants assisted by Fermilab and Sanford Lab staff, DOE will prepare an environmental assessment to determine what impacts LBNE construction and operation might have on human health and environment. Documentation will include a statement of project purpose and need, a description of the proposed project and alternatives, a description of the current environment, and an analysis of potential impacts to the air, sound, water, soil, safety, traffic flow and other impact areas. Opportunities to avoid any negative impacts that may exist would be integrated into the project plans. The project team will present all these aspects in a Draft Environmental Assessment document.

Opportunity for public comment

DOE will make the Draft Environmental Assessment document available to stakeholders in print and electronic form. It will be distributed via mail, posted in libraries and public reading rooms and shared through websites, e-mail and other electronic media. In addition, public meetings will be held at Fermilab and in South Dakota, likely in early 2014, to share the draft. The public will be able to provide comments either at these meetings or by submitting them in writing. The release and distribution of the draft document will include information on the dates of these public meetings and the ways that people can submit comments.

Preparation of the Final Environmental Assessment

After considering all comments, DOE will prepare a Final Environmental Assessment document. A record of the comments received will be contained within the document.

Decision-making

If the Final Environmental Assessment indicates no significant environmental impacts, DOE will issue a statement known as a Finding of No Significant Impact (FONSI) and will make the Final Environmental Assessment document and the associated FONSI available via mail, libraries and reading rooms as well as electronic media. If the Final Environmental Assessment indicates that potentially significant environmental impacts are likely to occur, a more extensive environmental review, referred to as an Environmental Impact Statement, will be undertaken to more fully explore those impacts. Additional public outreach opportunities would also be planned.

More information

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The LBNE Environmental Assessment Process: Public Outreach

1. Initial project planning
2. Start of the Environmental Assessment process → Letters, websites, informational meetings for the public, etc
3. Preparation of the Draft Environmental Assessment document
4. Opportunity for Public Comment → Public meetings, letters, comment forms, e-mail, etc
5. Preparation of the Final Environmental Assessment document
6. Decision-Making